Extraperitoneal Pneumography

A Preliminary Report

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SUMMARY

The presence of a gas in the retroperitoneal tissues makes possible a radiologic visualization of retroperitoneal organs and masses. Retropneumoperitoneum is accomplished by the injection of oxygen at low pressure into the tissues lying between the coccyx and the rectum. The technique of injection is simple and no complications have occurred with the first 30 cases. This method is particularly useful in outlining the kidneys and adrenal glands.

EXTRAPERITONEAL pneumography is a procedure in which a gas is injected into the extraperitoneal areolar tissue as a contrast medium to aid in roentgenologic visualization of the viscera which it surrounds. Carelli[3, 4] demonstrated in 1921 that carbon dioxide introduced into the renal fascia outlined the kidney, the kidney capsule and the adrenal glands. Cahill[2] reported in 1935 that he was able to determine the presence of hypertrophy and tumors of the adrenal gland by the use of this method. He also studied the adrenal gland in some patients with Addison's disease. Bariani[1] noted that when pneumoperitoneum was carried out there was sometimes an accidental diffusion of air between the parietal peritoneum and the transverse fascia which outlined the contour of the posterior abdominal viscera remarkably well.

Rivas[6] was the first to utilize generalized extraperitoneal emphysema for diagnostic purposes. By injection through a single puncture into the retrorectal areolar tissue, he produced diffuse and extensive emphysema in the cellular tissue of the entire body. This outlined the posterior abdominal viscera on roentgenograms better than previously used methods. Rivas termed this procedure retropneumoperitoneum.

ANATOMY

The anatomy of the extraperitoneal tissue has been extensively described by Rivas[7] and will be presented only briefly in this report. Between the fascia which covers the inner surfaces of the abdominal muscles and the peritoneum lies a considerable amount of extraperitoneal areolar tissue loaded with fat. It is part of an extensive layer which lines all the body cavities outside the various serous sacs, and it is continued on the various vessels, nerves and other structures which pass from the trunk into the limbs.

In the abdomen it is divisible into a parietal and a visceral portion. The former lines the walls, while the latter passes between layers of the peritoneal folds to the viscera. The parietal portion is thin and comparatively free from fat over the roof and anterior wall of the abdomen. In the pelvis this tissue is loose and fatty, and is continued up for some distance on the anterior abdominal wall, thus permitting the ascent of the bladder during its distention. In the posterior wall the tissue is large in amount, and fatty, particularly where it surrounds the great vessels and kidneys.

The visceral portions extend from the parietal portion along various branches of the aorta. The extensions are connected with the areolar coats of the blood vessels and pass with them into the mesenteries and other folds of the peritoneum, and thus reach the viscera.

The chief functions of the extraperitoneal tissue are to unite the peritoneum to the fascial and muscular layers of the abdominal wall, and to connect the viscera to the wall and to one another in such a loose manner that there will be no interference with their distention or relaxation. In addition, it is a storehouse of fat, forms sheaths for the vessels and nerves, and establishes, through a vascular plexus, communication between the parietal vessels and those distributed to the abdominal viscera.

TECHNIQUE

The authors used a procedure by which satisfactory roentgenographic outlines of some of the retroperitoneal organs were produced without causing great discomfort to the patient.

The equipment and materials used were: A local anesthetic ointment; 0.5 per cent procaine solution; a No. 20 or No. 22 spinal needle; a No. 26 hypodermic needle; a 5 cc. syringe; two Kelly bottles and rubber tubing connected to provide injection pressure as used for pneumothorax, and a pressure source of oxygen. Oxygen rather than carbon dioxide was used as the contrast medium because the rate at which it is absorbed is slow enough to give adequate time for satisfactory roentgen examination before the contrast begins to diminish. Air, which is absorbed even more slowly, would of course give more time for examination, but with it there would

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be greater hazard of serious embolism should a vascular channel be invaded. A further advantage of oxygen is that it is available on any anesthetic equipment.

In most patients the tip of the coccyx is easily palpable relatively high in the internatal cleft; the injection needle may then be most easily inserted with the patient on his left side with knees drawn up. In the case of the obese patient with large buttocks, the coccyx lies deep in the internatal cleft and the lithotomy position has been found to be the position of choice.

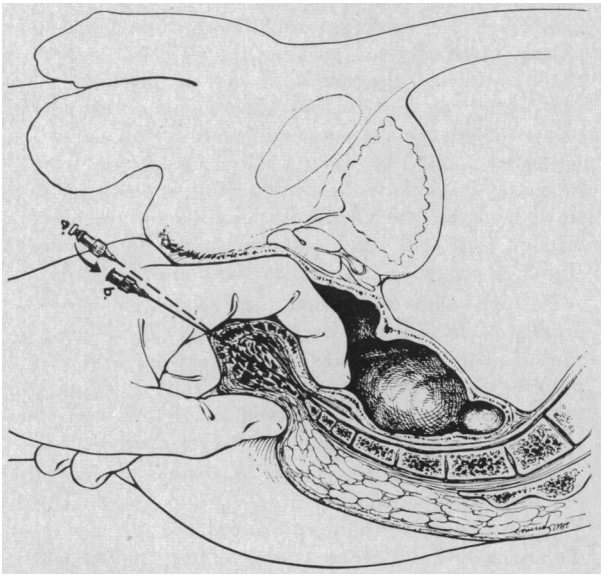

Figure 1.—Placement of the needle: (a) Plane of insertion to depth of coccygeal tip. (b) Final position for injection above anococcygeal raphe.

The anus is anesthetized with anesthetic ointment. The injection site is then prepared with antiseptic solution. A skin wheal of procaine is raised in the midline between the anus and coccyx, 1 to 2 cm. from the latter. The spinal needle, with stilette removed so that vascular intrusion will be obvious if it occurs, is then inserted through the skin and subcutaneous tissue until the tip impinges upon the tip of the coccyx. The index finger of the opposite hand is placed in the rectum and the needle is then redirected so as to slide along the anterior surface of the coccyx and through the anococcygeal raphe. The needle is then inserted another two or three centimeters, always with the point as far posterior as possible to avoid perforating the fascia propria of the rectum (Figure 1). The plunger of the syringe is withdrawn slightly to test for the perforation of a vessel and, if no blood is withdrawn, 2 or 3 cc. of air is injected. If the air does not flow easily, moving the needle or ballotting the point with the rectal finger usually will produce adequate flow.

If a generalized extraperitoneal pneumogram is desired, the patient is placed in the prone position with the head of the table tilted 10 to 15 degrees upward. If visualization of a single side is desired, the patient is placed in the lateral position with that side elevated and the table at the same angle as

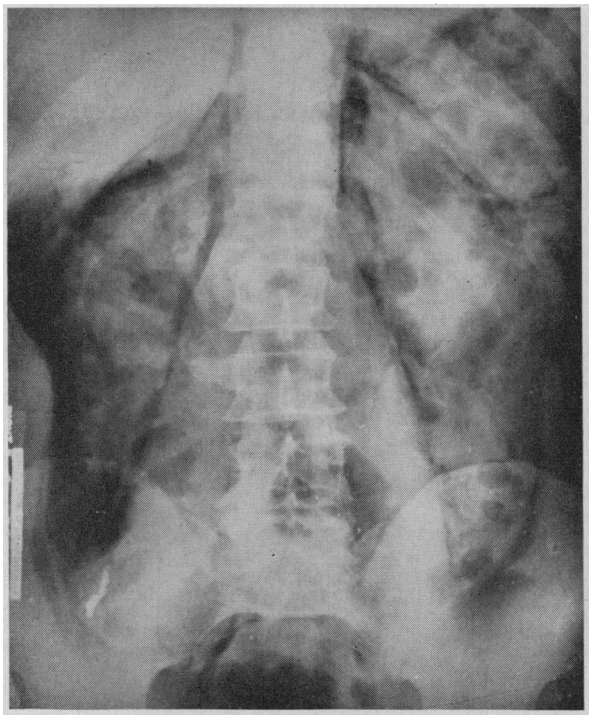

Figure 2.—Normal extraperitoneal pneumogram. The kidneys, adrenals, psoas shadows, liver, spleen and bladder are outlined by gas.

Figure 3.—The gas outlines the posterior pelvic viscera well on the left side, but poorly on the right side. The patient lay on his right side soon after injection so that the gas rose to the elevated left side. A subsequent extraperitoneal pneumogram demonstrated the posterior pelvic viscera on the right side well.

before. The oxygen supply is then attached to the needle by means of a sterile section of rubber tubing containing a cotton filter. The oxygen is allowed to flow in at a rate of about 100 cc. per minute under pressure of 20 cm. of water. If greater pressure is needed, the position of the needle is not correct and must be adjusted. Volumes varying from 200 cc. to 1,200 cc., depending upon the size of the patient, have been used in the studies to date. In those patients with little properitoneal and perinephric fat, adequate roentgenograms are produced with volumes as low as 600 cc., whereas in the well-padded patient a liter or more is required.

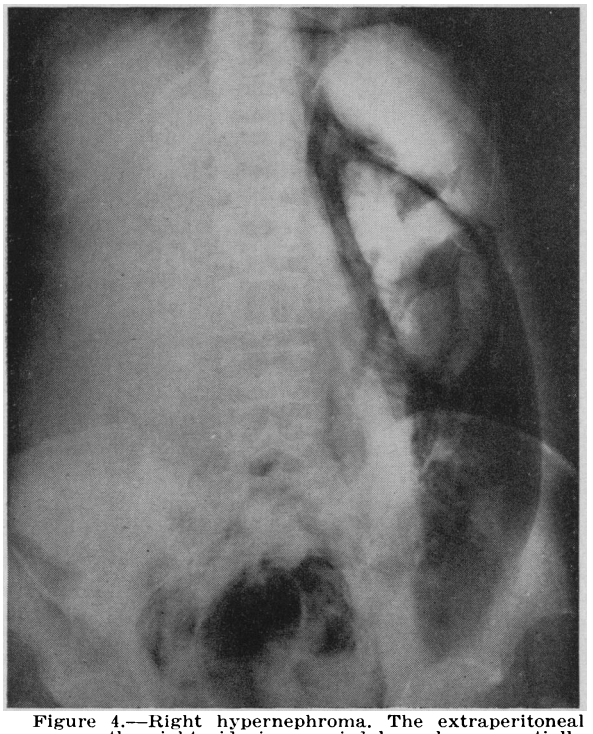

Figure 4.—Right hypernephroma. The extraperitoneal space on the right side is occupied by a large, partially calcified mass. The kidney, adrenal gland, and spleen are well outlined on the left side. There is no gas in the extraperitoneal tissue on the right side because the areolar tissue is compressed by the large mass.

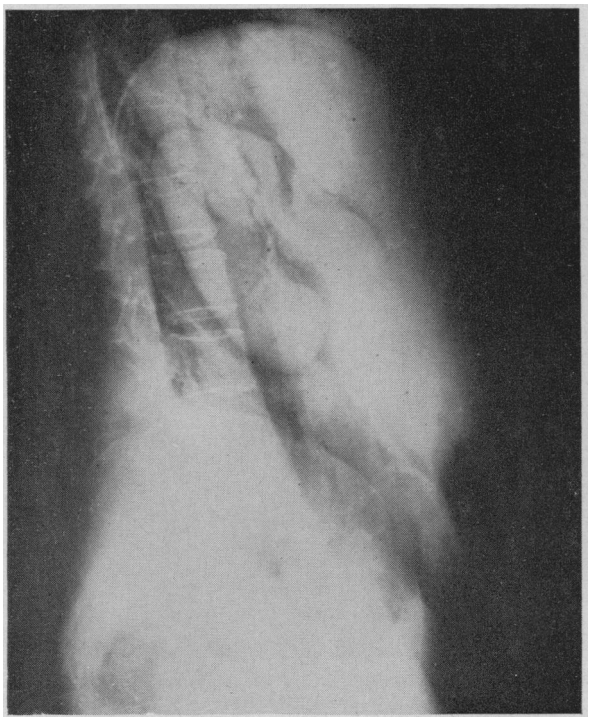

Figure 5.—Same patient as Figure 4. The lateral view demonstrates the left kidney well. The renal artery can be seen.

During the insertion of the needle a finger is placed in the rectum to keep the injector aware of the position of the needle point. If the rectum is perforated, or blood is withdrawn after the needle has reached the anococcygeal raphe, the needle is withdrawn and the examination postponed for 24 hours. If subcutaneous emphysema appears around the perineum, the needle has not been inserted far enough and still rests outside of the anococcygeal raphe. It must be inserted at least another 2 cm.

Patients who underwent this procedure were remarkably free from discomfort. A fullness in the region of the rectum was usually noticed first. Some patients noted a dull ache in the flank after 400 to 500 cc. of the gas was injected. In no case was this severe enough to interfere with the examination.

The patient remains in the position in which the gas was injected until roentgenograms are obtained. The posterior abdominal organs are usually best demonstrated about two hours after the injection has been completed. By that time the gas has extended throughout the extraperitoneal areolar tissue. Stereoscopic anteroposterior and lateral films are taken routinely. Tomography or body-section roentgenography has been found to be particularly helpful in that it eliminates the confusing shadows

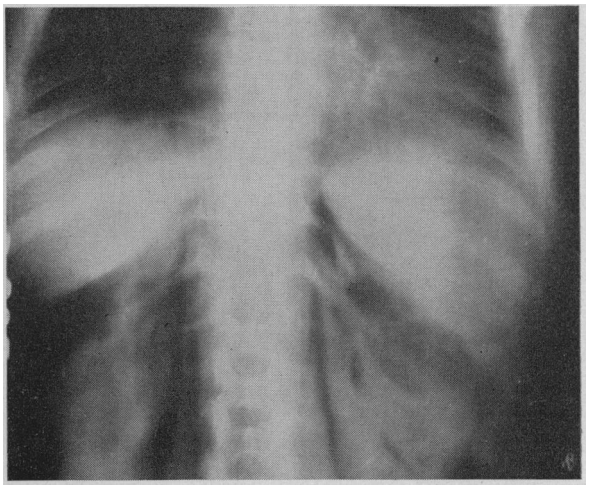

Figure 6.—Tomogram of a patient with Cushing's syndrome. The left adrenal gland is the triangular shadow outlined by gas above the superior pole of the left kidney. This gland appears to be normal. There is very little gas above the superior pole of the right kidney. An exploratory operation of the right adrenal gland was performed. It was found that the right adrenal gland was imbedded in firm areolar tissue which was separated with considerable difficulty. It freed quite easily from the upper pole of the kidney. It measured 4x2x0.5 cm. and was firmer than normal. Histologically there was evidence of hyperplasia.

caused by gas in the gastrointestinal tract and anterior abdominal wall. Additional films are taken as the need arises.

DISCUSSION

Rivas chose to inject the gas into the retrorectal areolar tissue because of its accessibility, its proximity to the extraperitoneal tissue of the posterior abdomen, and because of the absence of large blood vessels and vital viscera in that region. As the gas is injected at this site, it surrounds the rectum and extends into the cellular tissue of the parametrium which envelops the uterine tubes and ovaries. The gas extends upward along the psoas muscles, midabdominal vessels, kidneys, spleen and attachments of the diaphragm. The kidneys have their own closely adherent capsule around which is the sheath known as Gerota's sheath or capsule. This capsule encloses the upper part of the kidney and the adrenal gland. It is incomplete caudally where it communicates with the extraperitoneal areolar tissue, which also surrounds the capsule. The injected gas passes around Gerota's fascia and also extends through the defect inferiorly to outline the kidneys and adrenal glands. Some of the gas passes along the vessels into the mesentery and cellular tissue between the visceral peritoneum and wall of the stomach and bowel. If enough gas is injected it will rise into the extrapleural and mediastinal connective tissue through the apertures formed by the fibrous insertions of the diaphragm to the skeleton, and through the areolar tissue surrounding the great vessels and esophagus. The gas then passes into the areolar tissue of the neck.

The most important organs outlined by the gas are those in the pelvis and posterior abdomen. The gas injected into the retrorectal space helps in visualization of the uterus, tubes, ovaries and bladder, but these structures are partially obscured by gas surrounding the rectum and in the anterior abdominal wall. It has been found that gas may be injected directly into the cellular tissue of the parametrium through the vagina, thus outlining only those organs. The psoas muscles are sharply outlined. The external contours of the kidneys and adrenal glands stand out in contrast to the gas within Gerota's fascia. The margins of the spleen and liver are easily identified by the presence of the gas between them and the peritoneum (Figure 2).

The authors have been disappointed, as have the European investigators, in being unable to visualize the normal pancreas. This probably is due to the relatively small amount of areolar tissue surrounding it. It is hoped, however, that if a tumor or cyst of the pancreas that is not limited to the midline is present, it will be possible to visualize the lesion on either side of the midline where the areolar tissue is more abundant.

The procedure described was used in examination of 30 patients. There were no complications. Only one of the patients complained of more than mild discomfort. That patient, a woman, had pain in the back and it appeared to increase after the gas was injected. Three of the subjects were outpatients, and

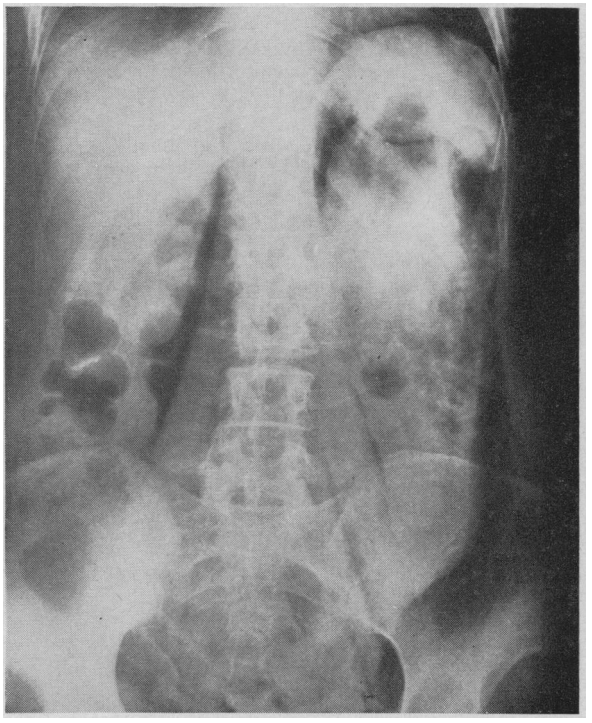

Figure 7.—Retroperitoneal tumor on the left side diagnosed as lymphoid hyperplasia by the pathologist. There is an absence of gas in the retroperitoneal areolar tissue lateral to the left psoas muscle. This is due to compression of the extraperitoneal tissue by the tumor mass.

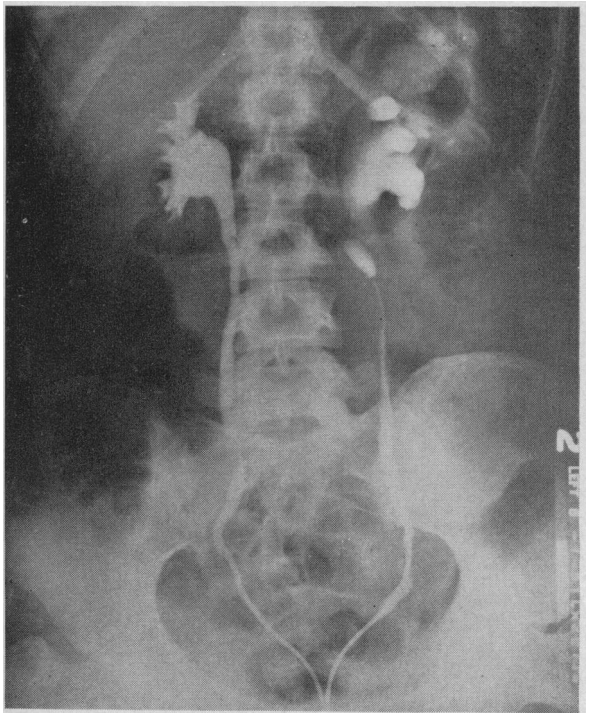

Figure 8.—Retrograde pyelogram demonstrating hydronephrosis and dilatation of the upper part of the left ureter, due to compression of the ureter by a metastatic mass. This patient had a carcinoma of the cervix.

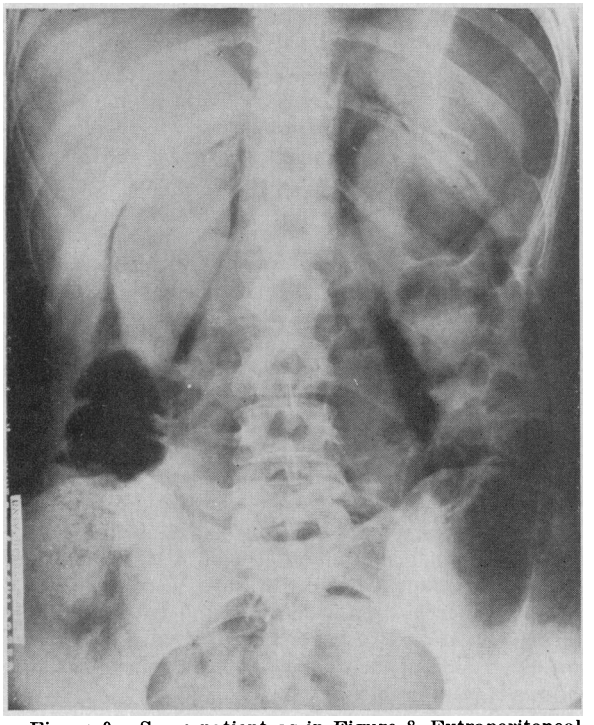

Figure 9.—Same patient as in Figure 8. Extraperitoneal pneumogram demonstrating the left hydronephrosis. The dilated kidney pelvis and upper part of the ureter on the left side can be seen medial to the kidney shadow.

they were permitted to return home on completion of the examination. One of the patients, who had paroxysmal tachycardia following a coronary occlusion, had no ill effects from the examination.

Pathologic conditions visualized by this method were: A lesion of the lumbar spine which caused distention of the paraspinous ligaments; hypernephroma; a retroperitoneal tumor; and in two cases, hydronephrosis which was not demonstrable by usual urological diagnostic techniques.

Extraperitoneal pneumography appears to be a valuable method for examining the posterior abdominal and pelvic viscera:

1. It is simple. The needle is inserted into the cellular tissue between the rectum and sacrum—a relatively easy procedure.
2. It appears to be safe. As there are no large vessels in the retrorectal space, there is little danger of air embolus.
3. The injection is not painful.
4. Only one puncture is necessary for diffusion of oxygen to both sides.
5. Structures other than the kidneys and adrenal glands are made visible.

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